CONSTRUCTION AND TESTING OF A FLAT BAR STRAIGHTENING AND ROLLING TYPE METAL BENDING MACHINE

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STUDENT DECLARATION

This is to certify that the thesis entitled, **"CONSTRUCTION AND TESTING OF A FLAT BAR STRAIGHTENING AND ROLLING TYPE METAL BENDING MACHINE"** is an outcome of the investigation carried out by the author under the supervision of **MD ISTIAQUE ZAHUR,** Department of Mechanical Engineering, SU. This thesis or any part of it has not been submitted to elsewhere for the award of any other degree or diploma or other similar title or prize.

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ABSTRACT

Mechanical Engineering without production and manufacturing is meaningless. Production and manufacturing process deals with conversion of raw materials inputs to finished products as per required dimension, specification and efficiently using recent technology. The new development and requirements inspired us to think of new improvements in manufacturing field. In our project Straightening and Rolling Bending Machine various diameters of flat bar is being bend with the help of this machine and various shapes is obtained like u-shape, circular, round shape, etc. It is widely used in various industrial operation such as bending a metal to make coil or sheet metal to make certain shape such as ‘U’ shape.

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CHAPTER 1

INTRODUCTION

The reason to design a Manual Roller and straighten Bending Machine for Flat bar bending is because there is no proper roller bender to bend a Flat bar for small scale. The Manual Roller and Straighten Bending Machine found in the market come from variety of types. There is roller bender such as press brake bending machine, roll roller bending machine. Moreover, the design for the roller and straighten bender for Flat bar bending is to bend a metal Flat bar. It produces sheet metal bending with desire degree of bending except 90°.

Other reason regarding to the roller and straighten bender design, the roller and straighten bender in the market come with big size and is expensive. The existing roller bender in the market is created for huge capacity for bending a metal flat bar. With the capacity of roller and straighten bender that exists in the market, the existing roller and straighten bender is not fulfilling the requirement of the usage.

The requirement of operation of roller and straighten bender is simple. Thus, it is not suitable to purchase existing roller and straighten bender to be used for simple roller bending operation. Also, the machine is heavy and use up a lot of space. In addition, the problem will arise when to move and put the roller and straighten bender due to heavy and space.

1.1 Literature review

The Industrial Revolution: opulent mechanical metalworking:

By the middle of the 18th century, one aspect of metallurgy had not changed: it was still an extremely physically demanding job. But as metal parts became more prevalent during the Industrial Revolution, hardwood threaded rods and wooden beams were gradually substituted. Metal levers, control shafts, and eccentric bearings were also used to close doors. To achieve precise bending results, the hardwood bending table was frequently strengthened with metal, the so-called edge rail. And when English industrialist John Wilkinson created the reverse rolling mill towards the end of the 18th century, mechanical sheet metal production truly took off [5].

Early 19th century: construction of the first "sheet metal bending brakes"

Since metal sheets were now widely available, their processing was swiftly mechanized as well. Around 1875, the first bending devices were known as "sheet metal bending brakes" or "folding benches." Although they were actual heavyweights, they undoubtedly made labor simpler. Then, hydraulics entered the picture; the locking lever and the bending tools were propelled by one or more hydraulic cylinders and managed by a straightforward lever valve. At first, only pure momentum was used to operate the shears manually; later, hydraulic power was added. For a very long time, the bend's position was established using a folding rule or template. Later, the first manually operated, adjustable back stop mechanisms were added to these.[6]

Between the beginning and the middle, bending systems grew more electric. the twentieth century. The first straightforward control mechanisms were created to manage the clamping, bending, and cutting processes. After that, bending machines practically managed themselves.

Beginning in 1973, the Swiss company Jorns produces bending machines.

The individual supports of the bending machines were still fastened to the ground on the clients' properties when the master mechanic Kurt Jorns took over the business of Konrad in Lotzwil, Switzerland. This was a problem because the statics varied depending on the substrate and could lead to errors when bent. Kurt Jorns identified this issue and created one of the first machine frames for the industry's unique bending machine. Jorns was able to introduce the first NCcontrolled bending machines in 1975: series 78 and 77. These were quickly followed by the first bending devices with an electronic rear stop and shears.

The development of the bending machine in the modern era:

Numerical controls (NC) were the foundation of the digital era for all machine tools. In the 1980s, thumb wheel switches for bending machines were added to them. For the clamping, bending, cutting, and back stop systems, precise values may be pre-set and run thanks to these. The amount of rows of thumb wheel switches placed a cap on a program.[8]

At the start of the 1990s, the first bending machines with CNC and monitor control systems were constructed. Additionally, measuring systems improved in accuracy and speed. The first back halt with a taper system were released on the market. At the end of the 1990s, visual control systems and touch screens that could be directly operated with a finger joined these. At the turn of the millennium, double bending machines that were fully automated made their debut.

1.2 Objectives

- To study about rolling type bending machine mechanism.
- To develop a straightening and rolling machine
- To test flat bar of different thickness

1.3 Need for Rolling and Straightening Bending Machine:

A bending is a process of bending a metal. The metal can be a sheet metal, tubes, square hollow, rod, and iron angle. This type of metal has its own thickness. In bending machine designing several considerations is taken into including type of metal, type of the roller bender, power driven or manual and the size of the bending machine. Usually, the difference of these types of bending machine is only on the capacity of the bending machine that can bend a sheet metal or tube. Today, the bending machine that available in the market is for the sheet metal and tube bending machine. Many machine makers vary their products based on the capacity of the bending machine and power driven or manual. Moreover, most of the machine uses roll bending type. This type of machine has 3 rolls which are 2 rolls is fixed and the other 1 adjustable. The sheet metal needs to put in the roller and then rolls around it until the desire shape is acquired. The products that can be produced with this machine are circular, U shape, round shape etc.

As we know that Roller and Straighten bends are used in various constructions things therefore it is necessary to build an economical Rolling and Straightening bending machine. It is also used in designing of various machine components, without this bending device a machine can’t work properly. It is used as far as industrial. The reason to design a bending machine is because there is no proper bending machine to bend a solid metal for small scale. The bending machines found in the market come from variety of types. There are bending machine such as press brake bending machine, roll bending machine.

CHAPTER 2

TYPES OF BENDING MACHINE

2.1 Tube Bending

The Forming Roller method of tube bending is recommended for all large bends where the centerline radius is at least 4 times the outside diameter of the tube. It can also be successfully employed for bending pipe or heavy wall tubing to smaller radii and is the most practical method of bending very small diameter tubing. [1]

Fig: 2.1 Tube Bending.

The Forming Roller and Radius Collar must be grooved to exactly fit the tube and the tube must not be allowed to slip during the bending operation as even a slight amount of slippage will cause distortion.

2.2 Rolling and Straightening Bending:

Straightening and Rolling bending as a process starts with loading a flat bar into a bender and clamping it into place between two rollers and a moving roller.

This operation is somewhat involved by the fact that most materials "spring back" after they have been formed. To compensate for this, it is often necessary to use a Radius Collar having a smaller diameter than that of the circle required. Actual size can best be determined by experiment, as the "spring back" varies in different materials. Material should be precut to exact length before forming.

Flat bar can be straightened by this bending machine for straightening round metal.

Fig: 2.2.(a) Rolling Bending.

Fig: 2.2(b) Straighten Bending

2.3 Channel Bending:

The same general bending rules which cover the forming of channel with “flanges out” also apply when it is formed with “flanges in.” Since it is necessary to compress the flanges as they are bent inward, the operation shown below requires considerably more bending pressure than when forming with the “flanges out” and it is recommended that the largest possible radius be used to allow for compression of the material. if a sharp 90° bend is desired, it can be obtained by cutting a notch out of the channel flanges before forming around a special Zero.[2]

Fig: 2.3 Channel bending.

Radius Block as illustrated. It is sometimes possible to make a circle in channel by using a segment of a Radius Collar similar. By following the procedure outlined on, the circle can be formed in three operations. To form channel with the flanges facing upward it is necessary to first fill it with Cerro bend or some other commercial filler as it is not possible to support the flanges in this position with a radius Collar.

2.4 Square Bending:

Forming zero radius bends around square, rectangular, or other multisided blocks employs the same principle used in scroll bending. Forming Nose “leads” material between corners of the block. Any number of zero radius bends can be obtained in one operation by this method in all types of solid materials. Both centered and off-center square eye can also be formed by following the same procedure outlined on. [3]

Fig: 2.4 Square bending.

This method of bending is limited by the size of the square block and the ductility of the material. In general, when squares larger than 1” are needed, they should be formed in progressive operations using the zero radius blocks.

2.5 V-bending:

The most common method is known as V-bending, in which the punch and die are "V" shaped. The punch pushes the sheet into the "V" shaped groove in the V-die, causing it to bend. If the punch does not force the sheet to the bottom of the die cavity, leaving space or air underneath, it is called "air bending". [4]

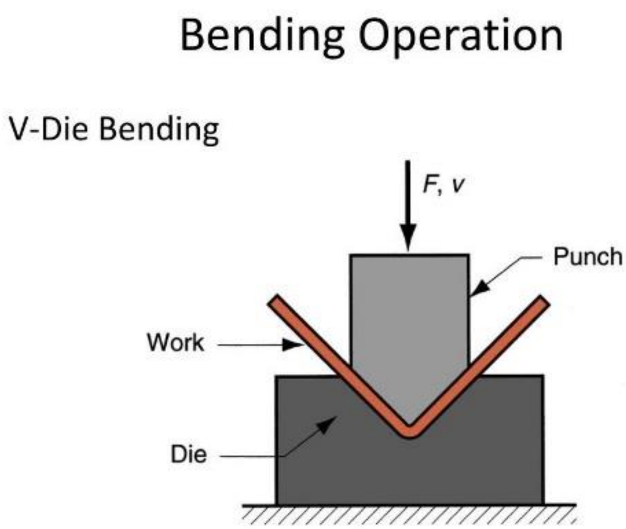


Fig: 2.5 V-bending

In v-bending, a wedge-shaped punch forces the metal sheet or strip into a wedge-shaped die cavity. The bend angle may be acute 90°, or obtuse. As the punch descends, the contact forces at the die corner produce a sufficiently large bending moment at the punch corner to cause the necessary deformation.

2.6 Sheet Metal Bending

Bending of sheet metal is a common and vital process in manufacturing industry. Sheet metal bending is the plastic deformation of the work over an axis, creating a change in the part's geometry. Similar to other metal forming processes, bending changes the shape of the work piece, while the volume of material will remain the same. In some cases bending may produce a small change in sheet thickness. For most operations, however, bending will produce essentially no change in the thickness of the sheet metal. In addition to creating a desired geometric form, bending is also used to impart strength and stiffness to sheet metal, to change a part's moment of inertia, for cosmetic appearance and to eliminate sharp edges.[5]

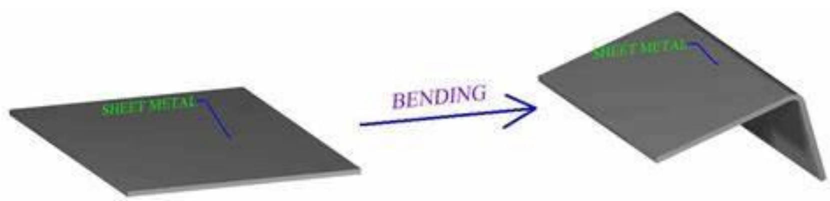


Fig: 2.6 Sheet Metal Bending

Metal bending enacts both tension and compression within the material. Mechanical principles of metals, particularly with regard to elastic and plastic deformation, are important to understanding sheet metal bending and are discussed in the fundamentals of metal forming section[6]. The effect that material properties will have in response to the conditions of manufacture will be a factor in sheet metal process design.

2.7 Hydraulic Profile Bending:

Hydraulic Profile Bending Machine – MAH series of hydraulic top roll profile bending machines are also the backbone of the biggest selection of roll benders in the world! Extremely user-friendly, again they are also completely accessible for apprentices and experienced operatives alike. Another key point of the hydraulic roll bender top roll position is displayed on the DRO, based within the free-standing operator control unit. The MAH hydraulic profile bender is perfect for those applications that require multiple passes, basically, where repeatability is key.[7]

Fig:2.7 Hydraulic Profile Bending

Available in two and also in three driven roll these machines can cater for the largest range of profiles in the market place. The three driven roll machines especially suit tighter radii and minimise material marking. Both horizontal and vertical working positions ensure that even in the smallest work spaces an MAH series **profile bender** will have its place. Our **Hydraulic Roll Benders** are a significantly compromise between capacity, repeatability, ease of use and reduction in production cycle times.

2.8 Sheet Metal Cutting Bending:

Sheet metal cutting is a major classification for many different pressworking operations. Cutting operations involve the separation of the metal of the sheet in certain areas. This separation is caused by shearing forces acting on the metal through the edges of the punch and die. Pressworking, a term referencing sheet metal operations in general, involves the working of a sheet between two die. In pressworking, the upper die is called a punch. Sheet and plate generally refers to rolled metal with a high surface area to volume ratio. The difference is that sheet metal is under 1/4 inch (6mm) in thickness, while plate metal is thicker. Most of the sheet metal cutting processes discussed can be performed on both sheet and plate metal, although for many sheet metal operations difficulties will arise with increasing plate thickness.[8]

Fig:2.8 Sheet Metal Cutting

One of the simplest types of press working operations is a sheet metal cutting process called a straight cutoff. A punch separates a length of stock along a straight line. Industrial sheet metal cutting operations such as this will usually incline the punch so as to reduce the maximum force needed by distributing the required force over the cutting stroke.

2.9 Schematic Diagram:

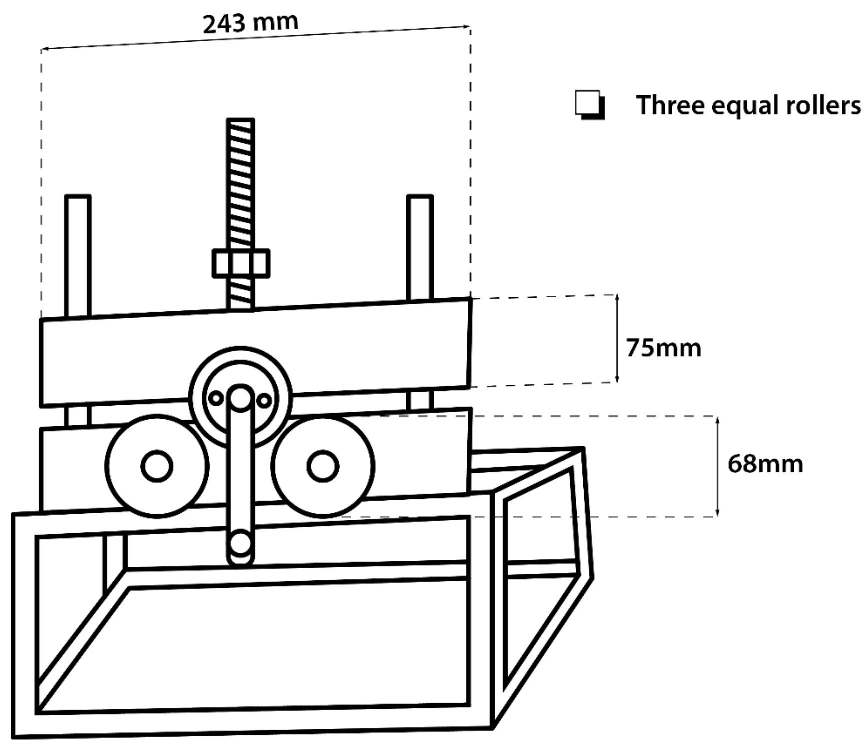


Fig:2.9 2D diagram and Measurements

This is the 2D diagram of our final project. Also, rollers, frame measurement showing on this figure.

CHAPTER 3

DESIGN OF STRAIGHTENING AND ROLLING MACHINE

Design:

3.1 Front and Side View

It consists of several parts namely: -

Fig:3.1 Front and side view

3.1.(a) FRAME- The frame provides support to the entire machine components.

Fig: 3.1.(a) FRAME

3.1.(b) Rollers- A bending roller consists of a vice which is welded to it and which is used to hold a metal firmly.

Fig: 3.1.(b) Rollers

3.1.(c) STAND- It is used to support the rod or pipe at other side.

Fig: 3.1.(c) STAND

3.1(d) LOCK PIN- A pin is inserted through a hole or holes and locks two parts together.

Fig: 3.1(d) LOCK PIN

3.2 SPECIFICATION

Table 3.1 different diameter of components:

Sr. No	Components	Specification
1.	FRAME	243mm x 75mm
2.	STAND	460mm x 325mm
3.	Roller	Radius= Outer 75mm, Inner 68mm and wide= Outer 46mm, Inner 36mm.
4.	Supporting Steel Rod	Length= 270mm

3.3 COMPONENTS REQUIRED

- Fixed Rollers
- Bearings
- Adjustable Roller
- Supporting Frame
- Stand
- Lock Pin
- Steel square hollow
- Threaded Rod
- Round Bar Steel Rod

Components Details

3.3(a) Bearing

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

Fig: 3.3(a) Bearing

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling, they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.[9]

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

3.3(b) Square Hollow Steel

Steel tubing with four equal sides, known as Square hollow section steel, is common for structural applications. Square hollow section is the abbreviation for SHS steel. A flat surface makes it easier to connect and weld, with minimum preparation of the edges needed.[10]

Fig: 3.3(b) Square Hollow Steel

SHS is made by progressively transforming a flat steel plate into a circular shape with ready-to-weld edges. The mother tube is formed by joining the edges of the rectangular tubes. The final square form is achieved via a succession of shaping procedures on the mother tube.

3.3(c) Threaded Rod

A threaded rod, also known as a stud, is a relatively long rod that is threaded on both ends; the thread may extend along the complete length of the rod. They are designed to be used in tension. Threaded rod in bar stock form is often called all-thread.[11]

Fig: 3.3(c) Threaded Rod

Threaded rod can be used anywhere a large screw, bolt or anchor bolt is used, however the main use for threaded rods is when the required length or diameter needed exceeds the more conventional bolts or screws.

3.3(d) Round Bar Steel Rod

This type steel rod is used to supporting the frame of the machine.

Fig:3.3(d) Round Bar Steel Rod

We carry metal round bar stock in alloy steel, aluminum, beryllium copper, brass, bronze, carbon fiber, carbon steel, cast iron, copper, maraging steel, nickel silver, nickel, plastic, stainless steel, and titanium. Most of our metal round bar is available in full size and custom cut lengths.

3.3(e) Thread Nuts:

A nut is a small metal object with a hole in the middle that has corrugated hole. These curved holes are known as threads. Nuts are used as a fastening device. It is important to note that evens though nuts are used as a fastening device, they cannot be used without bolts.[12]

Fig: 3.3(e) Thread Nuts

Both the bolt and the nut grip the materials being fastened, creating a bolt joint, with the nut also preventing axial movement.

The effect of the bolt joint comes down to the axial clamping force provided by the nut and the shank of the bolt, which acts as a rod that presses the joint against sideways shear forces. This is why so many bolt shanks are threadless – it makes for a stronger rod.

3.4 Project Final Work view:

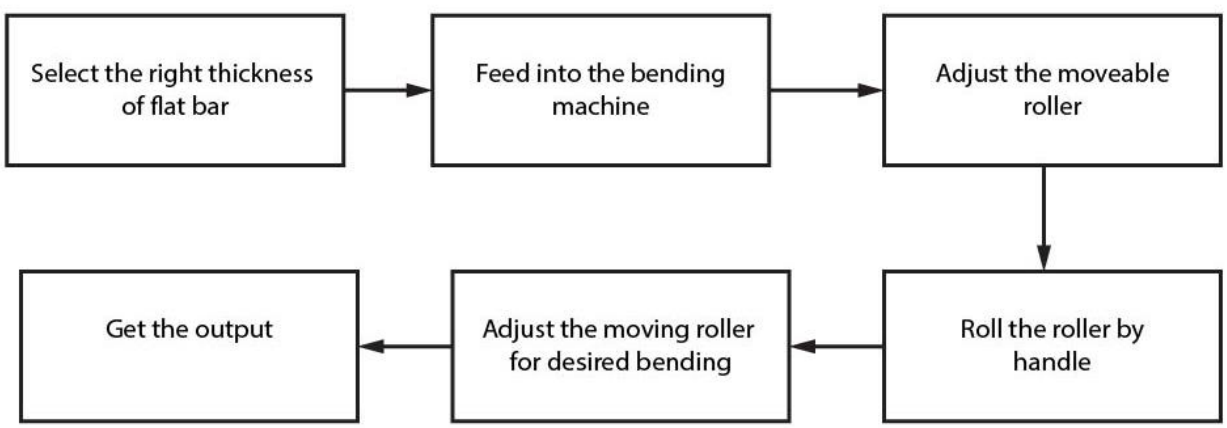
Fig: 3.4(a)Circular Bending

Fig: 3.4(b) U shape Bending

Fig: 3.4(c) Straightening

3.5 BLOCK DIAGRAM:

Working process step by step_



CHAPTER 4

WORKING PROCESS

Straightening and Rolling bending as a process starts with loading a flat bar into a bender and clamping it into place between two rollers and a moving roller.

This machine is a simple bending machine which is operated by a handle bar with manually. The handle bar is attached to the moveable roller of the machine.

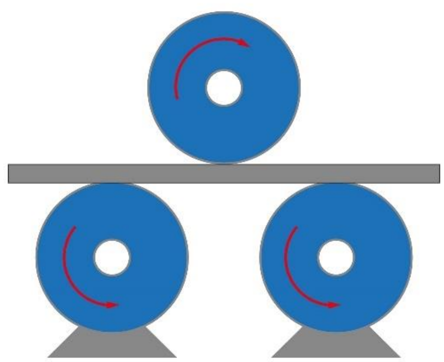


FIG: SCHEMATIC DIAGRAM OF WORKING STRAIGHTEN BEND

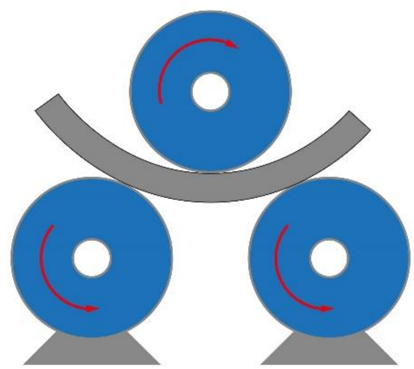


FIG: SCHEMATIC DIAGRAM OF WORKING OF ROLLER BEND

First of all, the convex site of the flat bar to be set in the roller of the machine and then manually start rotating is put on, then depending upon the dimension of the flat bar it is straighten. The power from the rotating manually handle bar is transferred which rotates the roller in clockwise direction and the flat bar straight for a given radius.

For Rolling bending:

The flat bar to be bend is set in the roller of the machine and then manually start rotating is put on, then depending upon the dimension of the rod it is bend. The power from the rotating manually handle bar is transferred which rotates the rollers in clockwise direction and the flat bar will be bend for a given radius.

CHAPTER 5

CALCULATION

FORMULA:

(1) Moment of neutral axis, M= $P \times d$

(2) Deformation, $\delta = \frac{\mathrm{PL^3}}{48EI}$

(3) Bending Stress, $\sigma = \frac{\mathrm{MC}}{\mathrm{I}}$

(4) Moment area of neutral axis, $\mathrm{I} = \frac{\mathrm{bh^3}}{12}$

(5) Perpendicular distance to neutral axis, $C = \frac{thickness}{2}$

(6) $d = \frac{length}{2}$

(7) $Area, A = b \times h$

Data Table:

SL No	Workpiece Length, L (m)	Workpiece Width, b (m)	Workpiece Thickness, h (m)	Deformation Value, δ (m)	Modulus of Elasticity, E (GPa)	Force, P (N)	Bending Stress, σ (MPa)
1	0.846	0.035	0.003	0.03	210	39.33	316.88
2	0.846	0.035	0.004	0.03	210	93.243	422.50
3	0.846	0.035	0.005	0.03	210	182.04	528.14

Calculation:

(1) Deformation, $\delta = \frac{PL^3}{48EI}$

Or, $P = \frac{48\delta EI}{L^3}$

$= \frac{48\times0.03\times210\times10^9\times7.875\times10^{-11}}{0.846^3}$

$= 39.33$ N

Bending Stress, $\sigma = \frac{Mc}{I}$

$= \frac{39.33\times0.423\times0.0015}{\frac{0.035\times0.003^3}{12}}$

$= 316.88 MPa$ (Ans)

(2) Deformation, $\delta = \frac{PL^3}{48EI}$

Or, $P = \frac{48\delta EI}{L^3}$

$= \frac{48\times0.03\times210\times10^9\times1.867\times10^{-10}}{0.846^3}$

$= 93.243$ N

Bending Stress, $\sigma = \frac{Mc}{I}$

$$= \frac{93.243 \times 0.423 \times 0.002}{\frac{0.035 \times 0.004^3}{12}}$$

$= 422.50 MPa$ (Ans)

(3) Deformation, $\delta = \frac{PL^3}{48EI}$

Or, $P = \frac{48\delta EI}{L^3}$

$$= \frac{48 \times 0.03 \times 210 \times 10^9 \times 3.645 \times 10^{-10}}{0.846^3}$$

$= 182.04$ N

Bending Stress, $\sigma = \frac{Mc}{I}$

$$= \frac{182.04 \times 0.423 \times 0.0025}{\frac{0.035 \times 0.005^3}{12}}$$

$= 528.14 MPa$ (Ans)

CHAPTER 6

APPLICATION AND ADVANTAGES

6.1 Applications:

- Mechanical Workshop
- Civil Construction site
- Agricultural Industries
- Metal Furniture Industries

6.2 Advantages

- Easily operated
- Simple construction
- Low cost
- Rigid construction
- Can be use small workshop
- Manpower does not require high skill

6.3 Disadvantages

- Accuracy less than automation
- Need to manpower
- Production rate less than automation

CHAPTER 7

FUNCTION AND REQUIREMENTS

7.1 FUNCTIONS OF MANUAL ROLLING AND STRAIGHTENING BENDING MACHINE:

- To bend a flat bar having thickness 3 to 5 mm in required round shape.
- To provide curvature shape to flat bar.
- Machine is convenient for portable work.
- The machine is power operated to achieve maximum accuracy in less time.

7.2 REQUIREMENTS

- Roller should be very accurate and easy to handle.
- The effort required to bend flat bar should be minimal.
- The rolling attachment should also provide directional stability.
- To bend metal sheet and pipe in one system.
- To operate the system Manually.
- To provide curvature shape to metal sheet.
- Machine is convenient for portable work.
- To easy the operation in small scale industries.

CHAPTER 8

Discussion & Conclusion

Such type quant for small scale work as well as industrial work in less cost and more precision and accuracy of different type of metal bending. The machine capacity can be increased according to the need. Manual bending tends to minimize wrinkles and can reduce springbuck. By its design the defects can be easily overcome. This approach can be used for bending a thin-walled metal over a small radius of the die, which can be achieved with a conventional method of bending the flat bar.

FUTURE SCOPE

- We can update to automatic.
- We can adjust different diameter of rollers
- as a result of which we can uses different diameter and thickness workpiece.

CHAPTER 9

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